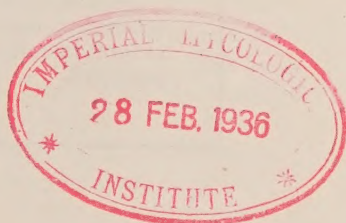

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A POTATO SEED PLAT ROGUING EXPERIMENT

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ABSTRACT

IN an experiment conducted in cooperation with a grower of certified seed potatoes in northern New York, a strain of Green Mountain potatoes was maintained in health and vigor during a period of 9 years by the use of an isolated and rogued seed plat. Altho neither mosaic nor leaf-roll were completely eliminated, both were kept so well under control that a crop of high grade certified seed potatoes was produced each year.

Details of the methods used are given and an estimate is made of the relative importance of the several factors involved in the success of the experiment.

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ORIGIN OF THE ROGUED SEED PLAT

The practice of growing seed potatoes in separate seed plats from which all weak and abnormal plants are removed before harvest time must have originated in attempts to improve the crop by seed selection. But just when or where or by whom it was started we do not know. Certainly, it was in use to some extent by advanced potato growers long before mosaic and leafroll were recognized as specific diseases. The writer recalls a conversation, in 1904, with T. E. Martin, an exceptionally successful potato grower of West Rush, N. Y. He said it was his practice to plant selected tubers in a separate seed plat, examine the plants frequently, and pull up every one that appeared in any way sick or weak.

That potatoes tend to "run out" has been known for a long time; but that "running out" is due to certain heritable diseases was not realized, even by plant pathologists, until less than 25 years ago. A notable American publication on the subject appeared in 1914 as Bulletin No. 64 of the United States Department of Agriculture and bore the title, "Potato wilt, leafroll, and related diseases." Its author, Dr. W. A. Orton, was a well-known American plant pathologist. This bulletin gave a great impetus to the investigation of the so-called "degeneration" diseases of potatoes. It was soon discovered that mosaic and leafroll are caused by an invisible something in the sap of diseased plants called "virus" and that this virus is transmitted from diseased plants to healthy ones by certain aphids which feed upon potatoes.

This new information pointed straight to the rogued seed plat as the practical remedy for the "running out" of potatoes and growers were urged to adopt the practice. The new knowledge of virus diseases also brought about the organization of the seed potato certification service which has been of enormous benefit to the potato industry. In New York, and also in several other potato-growing states, growers of certified seed potatoes are required to grow their own seed stock in separate seed plats. This regulation has been an important factor in extending the use of the rogued seed plat.

SOME EARLY EXPERIMENTS

Altho plant breeders and plant pathologists have not hesitated to recommend the rogued seed plat on theoretical grounds, they have, from the beginning, recognized the need of experimental proof that by its use a given strain of potatoes can be maintained in health and vigor over a period of years. Several short-term experiments of this kind have been conducted in different states and the results obtained appear to warrant the continuance of the recommendations. Also, the experience of the growers of certified seed indicates that the method is a practical one. However, some difficulties have been encountered and growers have sometimes failed to meet the requirements of the certification service.

Our own early experiments turned out badly. One of these was conducted at Geneva, N. Y., during the years 1919 to 1923, inclusive, with the variety Enormous No. 9, a member of the Rural group. The other was conducted at Malone, N. Y., during the years 1921 to 1923, inclusive, using the variety Green Mountain. Both experiments failed partly because of poor management and partly because of unusual weather conditions which made it very difficult to detect either mosaic or leafroll. An account of these experiments has been published in Bulletin No. 522 of this Station.

A NINE-YEAR ROGUING EXPERIMENT

LOCATION, METHODS, AND MATERIALS

Our subsequent study of the problem centered in an experiment with the variety Green Mountain in northern New York. It was conducted in cooperation with L. L. Foote on his farm 4 miles south of Malone, N. Y., during the seasons of 1924 to 1932, inclusive.¹ Each year during this period Mr. Foote grew from 6 to 8 acres of certified Green Mountain seed potatoes. The seed he used was grown in a separate seed plat at considerable distance from all other potatoes. The area of the seed plat varied in different seasons from a little less than $\frac{1}{2}$ acre to 2 acres. In some seasons the adjoining crops have been corn, barley, beans, etc.; but most of the time the seed plat has been surrounded by meadow containing clover, timothy, and many kinds of weeds. The tuber-unit method of planting was employed thruout. Mr. Foote sprays with bordeaux mixture and

¹The writer takes pleasure in acknowledging his indebtedness to Mr. Foote for the highly efficient manner in which he carried thru his part in this experiment.

arsenates fairly thoroly, but has sometimes failed to control the Colorado potato beetle as well as should have been. No special spray for the control of aphids was used.

The roguing was done by Mr. Foote with some assistance from the writer each year except 1932. Every plant showing signs of mosaic, leafroll, or other virus disease or abnormality, together with its tubers if any had formed, was promptly removed and carried away from the field. A record was kept of the number of plants so removed each season.

The tubers used for planting the seed plat were taken from the crop of the seed plat of the previous year. Each year at digging time hills were selected for yield, fewness of tubers, and trueness of tubers to type.

Each year the crop from the seed plat was tested for mosaic and leafroll in three different ways, as follows: (1) A random sample of 100 to 150 small tubers was tested by the writer in the Experiment Station greenhouse at Geneva; (2) a random sample of 100 medium-sized tubers was given a field test at Ithaca by a plant pathologist in the New York State College of Agriculture; and (3) the greater part of the crop of the seed plat was planted by Mr. Foote on his farm at Malone and entered for certification with the New York Seed Improvement Cooperative Association.

Under the regulations of the Association fields to be certified must pass two rigid field inspections for virus diseases made by a qualified plant pathologist of the State College of Agriculture. Certification may be refused if, at the first inspection, the amount of either leafroll or mosaic is above 2 per cent; or if, at the second inspection, more than 0.5 per cent of either disease is found. The inspections may be made at any time without advance notice to the grower. The grower is expected to remove all diseased plants as soon as they can be detected; also, to remove promptly all diseased plants found by the inspector. The only record we have of the number of diseased plants in the certified field is that supplied by the Inspection Service and this shows only what the inspector found. It does not include diseased plants removed by Mr. Foote before the arrival of the inspector. The results of these several disease tests are shown in Table 1.

The seed used in the seed plat in 1924, at the beginning of the experiment, had been tested for virus diseases by the tuber indexing method devised by Blodgett and Fernow.² Only tubers shown by

²Blodgett, F. M., and Fernow, Karl. Testing seed potatoes for mosaic and leafroll. *Phytopath.*, 11: 58. 1921.

TABLE 1.—RESULTS OF TESTS FOR VIRUS DISEASES IN POTATO ROGUEING EXPERIMENT AT MALONE, N. Y., 1924-32.

YEAR	IN THE SEED PLAT AT MALONE				TUBER TESTS OF THE CROP							
	Disease in tubers planted		Signs of disease in the foliage		In greenhouse at Geneva		In test field at Ithaca*		Inspection		In multiplication field at Malone*	
	Mosaic, per cent	Leafroll, per cent	Mosaic, per cent	Leafroll, per cent	Mosaic, per cent	Leafroll, per cent	Mosaic, per cent	Leafroll, per cent				
1924.....	0	0	0	2.6	0	0	3.0	0	1 st 2 nd	1.0 0	Mosaic, per cent	Leafroll, per cent
1925.....	0	0	1.8	0	4.5	0	0	0	1 st 2 nd	0.2 0.4		
1926.....	4.5	0	3.0	Trace	0	0	1.0	0	1 st 2 nd	0.6 0.4		
1927.....	0	0	0.3	Abn.† 0.1 0.1	3.0	1.5	2.0	1.0	1 st 2 nd	0.6 0.2		1.8 0
1928.....	3.0	1.5	4.7	1.5	0.8	0	2.0	0	1 st 2 nd	0.2 0.4		0.4 0
1929.....	0.8	0	0.26	Abn.† 0.39 0.26	1.7	1.7	2.0	0	1 st 2 nd	0.4 0.1		0 0
1930.....	1.7	1.7	0.7	0	0	Abn.† 0 1.38	0	1.0	1 st 2 nd	0 0		Trace 0
1931.....	0	Abn.† 0 1.38	2.0	1.0	2.8	1.9†	3.0	1.0	1 st 2 nd	Trace 0		Trace Trace
1932.....	2.8	1.9†	?	?	0	0	0	0	1 st 2 nd	0 0.4		0 0

*Data obtained from inspection records of the New York Seed Improvement Association thru the courtesy of Doctor Karl H. Fernow.

†Abn. = Percentage abnormal but affected with neither mosaic nor leafroll.

‡Percentage affected with both mosaic and leafroll.

the test to be healthy were planted. In succeeding years the tubers used for planting the seed plat were not indexed. Hence, the percentage of disease in them was the same as that in the crop of the seed plat from which they came and the most reliable information we have on the subject is furnished by the results of the greenhouse tests which are shown in the middle two columns of Table 1. However, it should be borne in mind that the greenhouse test is not entirely reliable. Also, that a sample of 100 to 150 tubers is too small for an accurate test.

DISCUSSION OF RESULTS AS SHOWN IN TABLE 1

Some explanation should be made of the figures given for percentage of mosaic and leafroll in the two columns of Table 1 headed "signs of disease in the foliage". Since tubers affected with mosaic or leafroll almost invariably give plants affected by the same disease, and since new infections can rarely be detected during the season in which they occur, it follows that the figures for "disease in tubers planted" and the figures for "signs of disease in the foliage" should be the same. The fact that they are *not* the same is evidence of error in their determination. Beside the errors which may occur in the greenhouse test the field test also is subject to error. High temperature masks mosaic. Very wet or very dry soil and the premature decay of seed pieces make the detection of leafroll uncertain.

The same applies to the disease percentages in the two columns headed "in test field at Ithaca". They should agree with the percentages obtained for the greenhouse test of the same year and with those for the seed plat test of the following year (as shown in Table 1). But they do *not* agree. Differences in weather conditions may account for the differences in percentage of disease found. The seed plat at Malone and the field tests at Ithaca were made not only in different localities but in different seasons.

The variation in the amount of disease from year to year (shown in columns 2 and 3 of Table 1) is due chiefly to two things; viz., (1) in some seasons virus diseases spread more readily and more widely than in others, due, probably, to differences in the number of aphids present; and (2) in some seasons the detection of virus diseases is easier than in other seasons.

The highest total percentage of disease detected in any test in any year was 6.2 (4.7 per cent mosaic plus 1.5 per cent leafroll). It was found in the seed plat test of 1928. Probably this was due to

the abundance of aphids in 1927 and to the ease with which mosaic and leafroll could be detected at Malone in 1928. In the multiplication field at Malone, planted with seed grown in 1927, the inspector found 1.8 per cent of mosaic and no leafroll in the second inspection. This is the only time during the 9 years of the experiment when the percentage of disease found in the multiplication field approached at all closely the 2 per cent tolerance allowed by the certification rules.

IMPORTANCE OF CERTAIN METHODS AND FACTORS

Now, let us examine more closely some of the methods employed and some of the factors involved in the experiment in order to determine, if possible, what has contributed most to its success.

Location.—The writer is of the opinion that the location of the experiment at a considerable elevation (about 1,200 feet) in northern New York where, usually, the summer temperatures are not high, is an important factor in its success. The extensive masking of mosaic, such as occurred in 1921, is probably rare at Malone. It did not happen during the period of 9 years covered by the experiment. At a lower elevation in central or western New York the experiment might not have turned out so well.

Earliness and thoroness of roguing.—Considering the manner in which mosaic and leafroll are transmitted from diseased plants to healthy ones the importance of removing diseased plants early is plainly indicated. Mr. Foote has done this. He makes frequent inspections and removes diseased plants as early as they can be detected. Also, it is highly important to remove *all* of the diseased plants. The man who does the roguing must have sharp eyes and know how to use them. Mr. Foote is a keen judge of potato plants. Every plant which appears to be abnormal in any way is removed. We regard this as one of the most important factors in his success.

Tuber-unit planting.—This is important because it facilitates the detection of diseased plants. If one plant of a tuber-unit is diseased, the others, also, are quite certain to be affected even tho they do not plainly show it. Hence, all should be removed. Mr. Foote has followed this practice.

Isolation of the seed plat.—The only other potatoes anywhere about the seed plat have been Mr. Foote's multiplication fields which have been planted with seed as free from disease as that used in the seed plat. Moreover, these fields have been thoroly rogued. In different years they have been located at distances varying from about 140

to 700 feet from the seed plat. In this respect the conditions for disease control in the seed plat have been better than the average.

Weeds and rose bushes.—Weeds adjoining a potato seed plat may be a menace because some kinds of weeds are affected by some of the virus diseases of potatoes. Many kinds of meadow weeds grew close about Mr. Foote's seed plat, but no study of them was made and how much harm they may have done is not known.

Rose bushes are regarded as a menace to the potato seed plat because the pink and green potato aphid (*Macrosiphum solanifolii*) one of the two species chiefly responsible for the spread of mosaic and leafroll; overwinters in the egg stage on rose canes.³ The only rose bushes near Mr. Foote's seed plat were a few plants in his garden about 100 yards distant. Little attention was given these plants, but they were sometimes sprayed with nicotine to prevent the accumulation of aphids upon them.

Aphids.—Apparently, potatoes at Malone are not often much infested with aphids. In our experiment they were plentiful in only 1 year out of 9. No doubt this has been a factor of considerable importance in the success of the experiment.

Premature decay of seed pieces.—In 1930, 16 per cent of the hills in the seed plat were missing and many plants were undersized due to the premature decay of the seed pieces. This condition appears to have resulted from planting freshly cut seed in very warm soil and a heavy rain following within 48 hours. In 1931, also, there was some trouble of the same nature, but the damage done was not so great as in 1930. Altho weakness resulting from premature decay of the seed piece is not heritable the presence of many undersized plants makes thoro roguing difficult. It was an unnecessary handicap to the experiment.

SUBSEQUENT RESULTS

During the three seasons of 1933, 1934, and 1935 which have elapsed since the termination of the formal experiment, Mr. Foote has continued to work along the same line with the same strain of potatoes and has maintained the high record established in the experiment. There appears to be no good reason for believing that the potatoes will "run out" so long as these methods are continued.

³Patch, Edith M. Rose bushes in relation to potato culture. *Maine Agr. Exp. Sta. Bul. No. 303. 1921.*

SUMMARY

The rogued potato seed plat has an obscure origin. Recently it has come into prominence and wide use as the principal measure in the control of leafroll, mosaic, and other virus diseases of the potato. Its value for this purpose has been proved by experiments conducted in several states; also, by the experience of growers of certified seed potatoes. Occasional failures have been reported. They are due, we believe, either to careless management or to the masking of symptoms by high temperature as happened in some earlier experiments made by the writer.

The results of a later experiment, reported in this bulletin, may be summarized as follows: Thru the use of an isolated and carefully rogued seed plat for growing the seed he plants, it has been possible for a grower in northern New York to produce a high grade of certified Green Mountain potatoes from fields of 6 to 8 acres during 9 consecutive years. The experiment was begun in 1924 with seed containing 2.6 per cent of virus diseases and ended in 1932 with a crop in which the official inspector found a total of only 0.4 per cent of virus diseases in two inspections.

It is believed that the success attained in this experiment is due chiefly to: (1) The favorable location where high temperatures occur but rarely and where aphids are not often plentiful on potatoes; (2) to the earliness and thoroness of the roguing; and (3) to the use of the tuber-unit method of planting in the seed plat.

By the continuance of these methods it is probable that this strain of potatoes could be maintained at the same high standard of health indefinitely.

